Interim Report

Project

Prevalence and behaviour of sharks in Cid Harbour

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Summary

In response to three shark bite incidents that occurred in Cid Harbour, Whitsunday Islands, between September and November 2018, The State of Queensland, acting through the Department of Agriculture and Fisheries, commissioned a scientific study to investigate the prevalence and behaviour of sharks in the Cid Harbour region. The present report reports the results from the first field trip to Cid Harbour, conducted between December 13th and 19th, 2018. Several sampling methods were tested, including catch methods (single hook droplines, longlines), baited underwater video cameras (BRUVs), drones and acoustic and satellite tracking. Because of the bad weather brought in by Ex-Cyclone Owen, sampling by drones was not possible, due to reduced water and surface visibility. However, catch methods, BRUVs and acoustic and satellite tracking provided useful information.

Overall, results show that the number of sharks using Cid Harbour at the time of sampling were low. Catch rates from the shark control program that operated for a week in September 2018 were also low. Sharks caught/sighted were mostly tiger sharks, spot-tail sharks and tawny nurse sharks. Regarding tracking, ten acoustic receivers were deployed in the Cid Harbour area, and five sharks were tagged with acoustic transmitters (four tiger sharks and one spot-tail shark). Additionally, six sharks were fitted with satellite transmitters (four tiger sharks, one great hammerhead and one scalloped hammerhead shark). So far, three of those sharks have been providing movement information, with data showing that all three sharks left Cid Harbour after being tagged, but remained in the general Whitsunday Islands region.

Background

In response to three shark bite incidents that occurred in Cid Harbour, Whitsunday Islands, between September and November 2018, The State of Queensland, acting through the Department of Agriculture and Fisheries, commissioned a scientific study to investigate the prevalence and behaviour of sharks in the Cid Harbour region. Other stakeholders such as the tourism industry support the study and are providing assistance in particular with the social science component of the project. The overall aim of this project was to improve our understanding of the shark species present in the area, the relative abundance of potentially dangerous species, and the behaviours of those species (including habitat use and residency within Cid Harbour and the surrounding area) and of humans that use the area for recreational purposes. This information will be useful to better understand the causes of shark bites in Cid Harbour so that appropriate, science-based, management measures can be devised and implemented to adequately address the shark bite issue in the short- and long-term. In the present interim report, we report the results from the first field trip.

Methods

The first field trip of this project was undertaken between December 13th and 19th to investigate the occurrence and species composition of the shark community using Cid Harbour and to set-up the movement behaviour study. The present report covers the results gained from this trip, and provides updates on the progress of the social science component of this project.

Note that during the tender process several methods were proposed to be used to address the desired objectives. However, the efficacy of some of those methods was compromised due to bad weather conditions during the first field trip, a result of the presence of Ex-Cyclone Owen. In particular, visual census methods such as the use of drones and underwater video cameras were of limited use due to extremely turbid waters. Additionally, due to the constant change in wind direction and strength, fishing effort had to be concentrated in the most protected area of Cid Harbour, which is also the area most used by anchoring boats and the location where shark bites occurred (see Figure 1c). This allowed monitoring of the lines from the mothership in all weather conditions.

Catch methods

Single hook droplines

In each of the six sampling days, eight single hook droplines were deployed between sunrise and sunset (approximately 5:30 h to 18:30 h) in the area between Sawmill Bay and Dugong Beach, at depths between 2 and 13 m (Figure 1c). Hook sizes were 16/0, 18/0 and 20/0, and bait was a mixture of mullet and mackerel species.

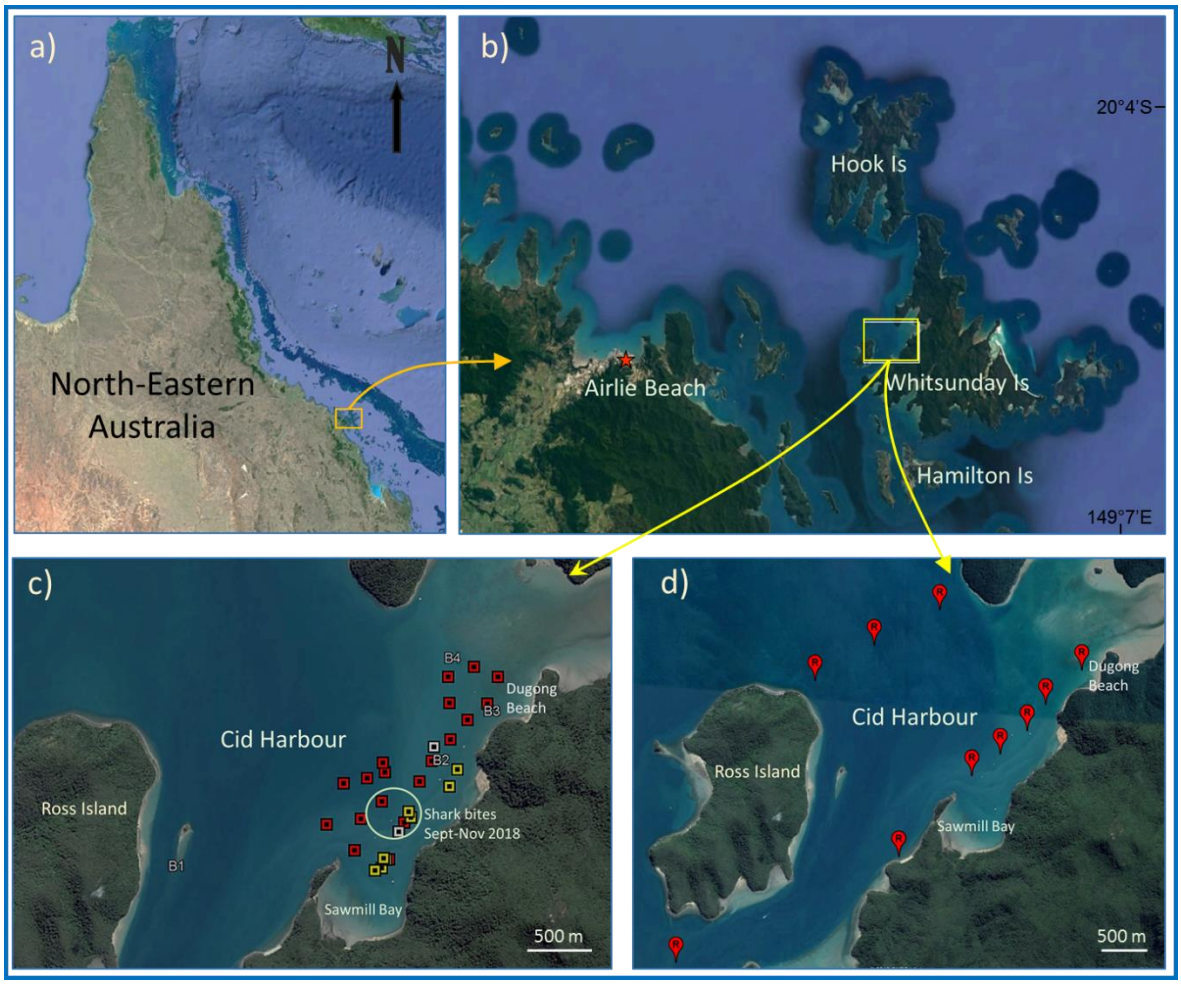

Figure 1. Study area, showing a) & b) the location of the study site; c) the locations of the droplines (red symbols), longlines (white symbols) and BRUVs (B1-B4) deployed during the present study, along with the location of the droplines deployed by Fisheries Queensland (21 - 29 September; yellow symbols) and the approximate area where the three shark bites occurred (September and November 2018; circle). d) Location of the acoustic receivers.

Longlines

Bottom set longlines were set in two locations, and consisted of 200 m led core lines with 27 hooks per line (0/12 circle hooks). The lines were set in 4-5 m of water, close to where the shark attacks occurred (Figure 1c).

In the present report, we also present catch data collected by the shark control contractor that operated between 21 and 29 September, following the first two shark bite incidents. In that work, three single hook droplines were set per day, between 6:30 h to 19:00 h. Hooks used were Mustad 4480DT size 14/0 "J" hook, and the bait used was whole mullet. Lines were also set overnight.

Baited underwater video cameras (BRUVs)

Baited underwater video cameras (BRUVs) were deployed for 1 hour at a time using four fixed locations (see Figure 1c for BRUV locations). BRUVs were set at least 500 m apart, at depths between 3 and 5 m, and 1 kg of pilchards was used as bait per drop. As with the fishing methods, initial BRUV sampling focused on the area where the majority of boats anchor, and where the shark bites occurred (Figure 1c). Unfortunately, underwater visibility in this area was less than 1 m at all times and therefore we also dropped cameras on the other side of Cid Harbour, near Ross Island (Figure 1c), in an attempt to gain information on the species using the broader Cid Harbour region. Note however that visibility in that area was also less than optimal, and ranged from 1 m to only 3 m.

Drones and automated underwater vehicles (AUVs)

Testing of drone flights showed that, as expected, poor water and surface visibility (due to turbidity and windy conditions) prevented this from being a useful method. Visibility in Cid Harbour is also too low for the use of automated underwater vehicle (AUV). The AUV requires clear water to position itself and move in relation to its surrounding environment. We expect that these methods will not be useful in the future as Cid Harbour is a low visibility environment. However, we will test again after the wet season if water clarity improves significantly.

Tracking shark movements and residency behaviour

Both acoustic and satellite tagging was focused on species that could potentially be responsible for shark bites.

Acoustic tracking

Ten acoustic receivers were deployed in the Cid Harbour region (Figure 1d). Three were placed at the north entrance of the harbour and one at the south entrance. These receivers effectively gate Cid Harbour and therefore detect any tagged sharks leaving or re-entering the broader Harbour area. The remaining six receivers were deployed in the area where shark bites occurred (Figure 1d), on 'Do-Not-Swim' signs moored in response to the shark bites. The acoustic array design will therefore monitor shark movement behaviour in the area where boats anchor and shark bites occurred, and also provide information on the residency of the tagged sharks in the broader Cid Harbour area. For tagging, caught sharks were placed belly up on the side of the boat, and acoustic transmitters were surgically implanted into the body cavity through a small incision. The incision was then sealed with surgical sutures and the shark released.

Satellite tracking

Satellite transmitters were attached to the dorsal fins of large shark species that frequently break the water surface. Satellite tagging data will complement acoustic telemetry data by providing information on shark broad scale movements. This information will be useful to help determine how Cid Harbour fits into the broader movements/distribution/home range of the species tagged.

Results

Catch data

Single hook droplines

The eight single hook droplines set per day during the six-day field work made up a grand total of 465 hours fished. Sixteen sharks were caught in the droplines: one great hammerhead shark (*Sphyrna mokarran*), six spot-tail sharks (*Carcharhinus sorrah*), five tawny nurse sharks (*Nebrius ferrugineus*) and four tiger sharks (*Galeocerdo cuvier*). Most sharks were captured

between 12:00 and 16:00. Only on five occasions was the bait missing from a hook; either a shark was on the line or, for the majority of cases, baits were not touched. The only other animal caught on a dropline was two catfish.

The shark control contractor that fished in September 2018 caught five tiger sharks and one common blacktip shark (*Carcharhinus limbatus*), from 216 day-time fishing hours. The contractor also reported that most baits were not touched, including when lines were set overnight.

Longlines

Longlines were set for a total of 11 hours. Six sharks were caught: one scalloped hammerhead (*Sphyrna lewini*), two tawny nurse sharks and three spot-tail sharks. The vast majority of baits were not touched.

Table 1. Species composition and size range of sharks caught on single hook droplines and longlines combined. *n* = number of sharks caught; TL = total length, in cm.

Species	Scientific name	Size range (TL)	n
Tiger shark	*Galeocerdo cuvier*	200 - 370	9
Spot-tail shark	*Carcharhinus sorrah*	50 - 173	9
Tawny nurse shark	*Nebrius ferrugineus*	150 - 270	7
Great hammerhead shark	*Sphyrna mokarran*	241	1
Scalloped hammerhead shark	*Sphyrna lewini*	171	1
Common blacktip shark	*Carcharhinus limbatus*	120	1
		TOTAL	**28**

*Seven of the spot-tail sharks were <100 cm TL.

In addition to droplines and longlines, on the first two nights of the trip we set a surface line with bait and a berley pot from the back of our boat to attract sharks. This was set for 3 hours each night. On both occasions, the bait was not touched.

Baited underwater video cameras

A total of 38 BRUV drops were deployed. Overall, the visibility of BRUVs was limited (Figure 2). Twenty four drops had visibility lower than 1 m (all drops at sites B2, B3, B4 – see Figure

1c for BRUV locations). The 14 drops deployed at site B1 had maximum visibility of 3 m (average visibility ~2 m). BRUVs recorded six sharks, belonging to four species, and six rays. From those, only the tiger shark and a whitecheek shark (*Carcharhinus dussumieri*) are candidates for the shark bites that occurred in Cid Harbour. The remaining species included brown banded bamboo shark (*Chiloscyllium punctatum*) and three tawny nurse sharks.

Taking into consideration the poor visibility, the lack of sharks recorded in 38 hours of video aligns with the low catch rates from our simultaneous fishing effort, and also with the low catches from the shark control contractor that fished directly after the first two shark bite incidents.

Figure 2. Images of a tiger shark and a turtle registered by a BRUV placed at site B1, the site with the highest visibility, showing the limited visibility present during the sampling period.

Shark movements and residency behaviour

Acoustic tracking

Of the 28 sharks caught, five were tagged with acoustic transmitters, including four tiger sharks and one spot-tail shark (Table 2). Tawny nurse sharks were not tagged as this species is highly unlikely to be responsible for bites (it is a 'placid' species that only has grinding teeth). Both hammerhead species were not acoustically tagged as they can be fragile and may not respond well to surgery (satellite transmitters were attached). Spot-tail sharks are also known to struggle to survive after capture, so we also avoided surgery for this species, and only tagged the one individual. More sharks will be acoustically tagged on the next trip. Movement results from acoustically tagged sharks will be downloaded, collated and analysed in October 2019, when the receivers are retrieved.

Satellite tracking

Six sharks were fitted with satellite transmitters: four tiger sharks, one great hammerhead and one scalloped hammerhead shark (Figure 3; Table 2). At the time of the present report (mid-January 2019, one month after tagging), two tiger sharks and the great hammerhead have been regularly surfacing and providing location information. All three sharks left Cid Harbour after being tagged, but so far remained in the Whitsunday Islands region (see Figure 4).

Figure 3. Fitting a satellite transmitter to a hammerhead shark.

Table 2. Size (total length, in cm) of sharks fitted with acoustic (AT) and satellite transmitters (ST).

Species	Latin name	Size (cm)	AT	ST
Spot-tail shark	*Carcharhinus sorrah*	176	✓	
Great Hammerhead*	*Sphyrna mokarran*	241		✓
Scalloped Hammerhead	*Sphyrna lewini*	171		✓
Tiger shark	*Galeocerdo cuvier*	340	✓	✓
Tiger shark*	*Galeocerdo cuvier*	230	✓	✓
Tiger shark*	*Galeocerdo cuvier*	242	✓	✓
Tiger shark	*Galeocerdo cuvier*	370	✓	✓

*= Shark/satellite transmitter has been regularly detected and location data reported.

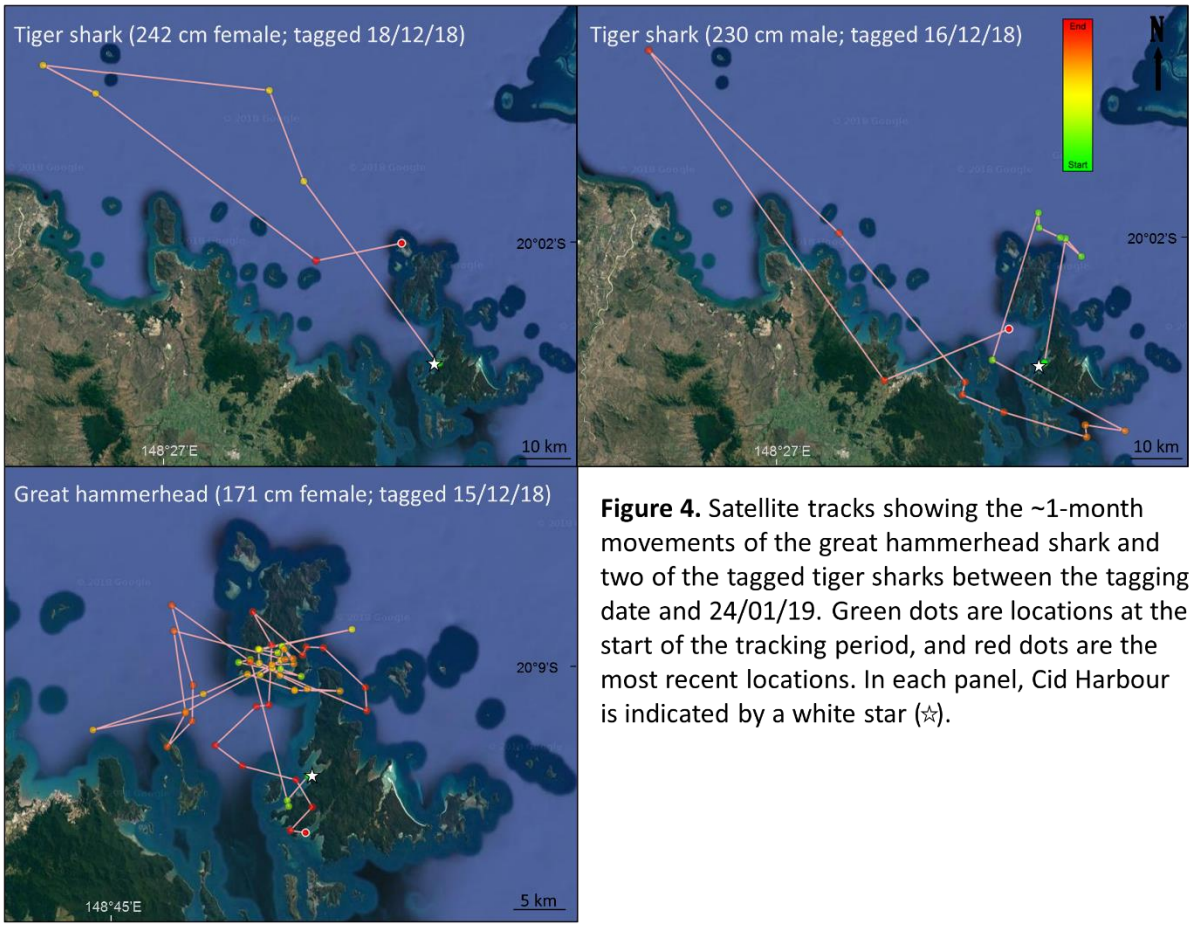

Figure 4. Satellite tracks showing the ~1-month movements of the great hammerhead shark and two of the tagged tiger sharks between the tagging date and 24/01/19. Green dots are locations at the start of the tracking period, and red dots are the most recent locations. In each panel, Cid Harbour is indicated by a white star (☆).

Social science update: User surveys

The user survey project has begun by establishing contact with managing agencies, tourism representatives, and consultative groups. Specifically, the social science team made introductions and had cursory discussions about the scope of the project with the following stakeholders:

- QLD DAF (Eddie Jabreen and Clair Anderson)
- GBRMPA Stewardship and Partnerships (Fred Nucifora)
- GBRMPA Reef Engagement (Kirstin Dobbs)
- GBRMPA regional office (Carolyn Roache)
- Whitsundays Charter Boat Industry Association (Sharon Smallwood)

The team will be meeting with the Whitsunday Local Marine Advisory Committee (LMAC) on February 12th, when it will also meet with key industry and community representatives to identify key informants and seek feedback on the preliminary sampling design. At this stage, the sampling design will include three elements:

1. A self-complete survey (both in hard copy and on-line) on harbour-user knowledge, awareness, and activities relating to *shark-smart* behaviours will be distributed through tourism operators;
2. A short convenience survey for tourists and recreational users will be distributed in Airlie Beach to collect information on broader *shark-smart* awareness and recreational activities; and
3. Semi-structured interviews of key informants to collect detailed local knowledge about the context of recreational and tourism use of Cid Harbour and bather safety issues.

During this visit, the social science team will also be refining the sampling design with tourism operators to ensure that survey trips are conducted at locations and times that will maximise sample sizes and response rates, and also confirm industry support for distributing the self-complete survey.

Discussion

Catches and sightings were mostly tiger sharks, spot-tail sharks and tawny nurse sharks. Despite the intense sampling effort on this field trip, shark catches/sights were very low. Similar low catches were obtained by the shark control operator that fished in September, days after the first two shark bite incidents. This, coupled with the lack of empty hooks, was somewhat surprising and suggests that not many sharks were using Cid Harbour during both sampling times. Also notable was the absence of bull sharks (*Carcharhinus leucas*) from all datasets (BRUVs, hook catches, and shark control catch), a species that has been implicated as the likely candidate for the shark bites in Cid Harbour. Note however that this first field trip took place when Ex-Cyclone Owen crossed the region, bringing with it heavy rainfall and strong winds. This, along with the low visibility environment that categorises Cid Harbour, limited the usefulness of methods that require good in-water and surface visibility such as BRUVs, drones and AUVs. For example, BRUV drops could only record animals that came right to the bait box (see Figure 2).

Despite the low number of sharks caught/sighted, observations suggest that Cid Harbour has abundant marine life that could be shark prey. During our trip, numerous turtles were observed surfacing, along with mackerels leaping out of water, dolphins moving around the bay, and shoals of baitfish were present around the boat at night. BRUVs also recorded turtles and bony fish, along with stingrays, species known to be important shark prey. Indeed, four of the five tiger sharks caught by the shark control contractor contained turtles in their stomachs. Data on prey availability collected throughout this trip is being compiled and will be presented in the Final Report (when we have more data).

Besides the presence of natural prey, it is also important to note that sharks are opportunistic scavengers. Up to 100 boats are known to use Cid Harbour in a day, and anecdotal evidence suggests many of those boats throw food scraps overboard, and some even intentionally attract sharks with food. This human behaviour could attracts sharks to the area, and in other parts of the world shark feeding has been shown to lead to changes in shark behaviour and movement patterns (Trave et al. 2017). Few boats used the Cid Harbour during our field trip (maybe due to bad weather?), with only one other boat present in the first four days, and only six boats present in the 5th and 7th days. This means that there was likely a much lower amount of food attracting sharks into the area than in 'normal' conditions. Therefore, while the low number of sharks caught on our trip and by the shark control operator initially suggests that Cid Harbour is not housing a high shark abundance, future field trips will be used to explore this observation.

Overall, and despite adverse weather conditions and tight timeline, the first field trip was successful. It was possible to conduct a significant fishing effort and important data on the shark species using Cid Harbour and on movement patters was obtained. In the next field trip, planned for after the wet season, we will hopefully have better weather conditions that will allow an increased sampling effort. Note also that, after discussion with Mackay's shark meshing contractor Geoff Bachman, we plan to deploy additional satellite tags in the Mackay area. Geoff provided anecdotal evidence that large sharks (e.g. tiger and bull sharks) move between Mackay and the Whitsunday Islands. If successful, this tagging exercise will help build up the numbers of satellite tagged sharks in the region, and contribute to a better understanding of the broad scale movement behaviour of these animals. This information will be critical to help devise management measures aimed at minimizing harmful shark-human interactions.

References

Trave, C., Brunnschweiler, J., Sheaves, M., Diedrich, A., Barnett, A. (2017) Are we killing them with kindness? Evaluation of sustainable marine wildlife tourism. Biol. Conserv. 209:211–222